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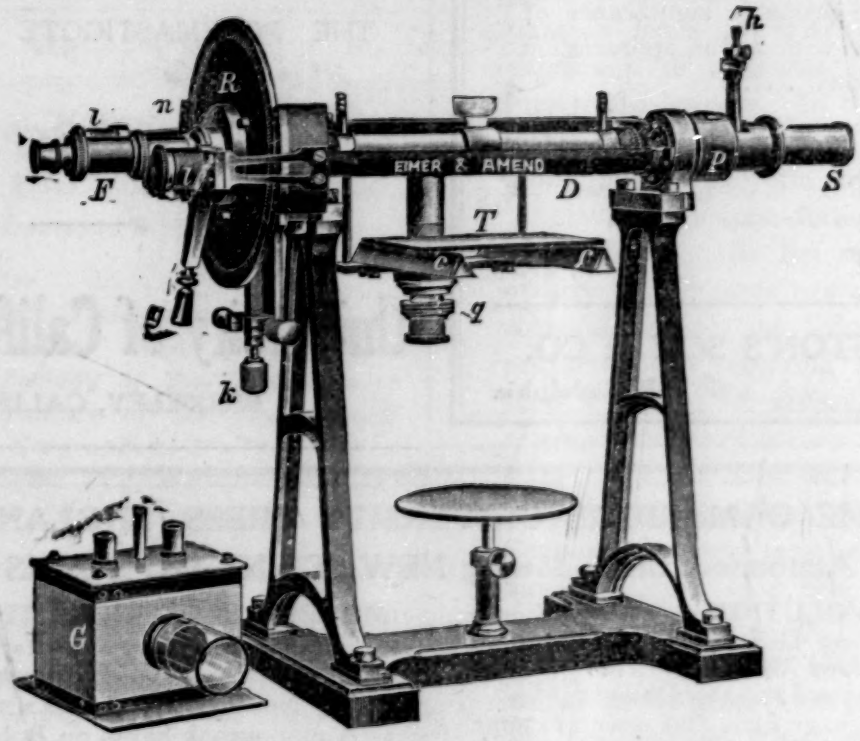

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INDIVIDUALISM IN MEDICAL EDUCATION[1]

IN human progress there are two fundamental processes which sometimes proceed equally, but usually one or the other is dominant,—these two processes are extension and consolidation. In the birth and growth of nations, there is first settlement in colonies due to community of thought and action; this expansion is followed by a union; national expansion leads to international alliances; the expansion of alliances leads to consolidation into world leagues. In the growth of religions many beliefs are unified by the Christian religion; then extension of doctrines leads to innumerable sects, followed by attempts at consolidation. In the more specialized fields of activity the same processes are observed. In celestial physics the theory of gravitation coordinated the scattered and divergent views; then a period of differentiation, followed by attempts at coordination in the theory of relativity. In the field of medical science there are many illustrations of the same procedure. Scattered observations on variations in the blood, phlegm, and bile, during illness were brought together in the humoral theory of disease; in like manner studies on bacteria were unified in the germ theory. Studies on heredity and environment found common expression in the theory of evolution. In the past, medicine was largely restricted to the diseases of mankind. At present she recognizes the intimate relationships of the diseases of plants and animals to those of mankind. In the near future she must take into consideration the diseases of metals; ultimately her domain will extend widely over both the organic and inorganic world. In the growth of knowledge in all of

[1] An address delivered before the Association of American Medical Colleges March 7, 1922.

its special fields and great provinces, and as a whole, two processes stand forth, namely, extension and consolidation, specialization and generalization. The vitalizing factors in these are: individual thought, and collective thought.

Whether one follows the theory of evolution or accepts the teaching of the book of Genesis, he must contemplate the beginnings of intellectual growth in the individual. Individual thought precedes collective thought. Individualism, in the abstract, postulates that each human being may live to the fullest extent his own life as he wills. According to Biblical history it attained its greatest development with the first inhabitant of the earth but did not reach its ideal. The family embodies the first step in the growth of collective thought; and as the family grows individuality becomes restricted. Here and there it breaks away from the common modes of thought and action and asserts itself in differences so pronounced that one member becomes a genius while another becomes a black sheep—a Rocail and a Cain. Rocail erects a sepulchre adorned with statues of various metals, made by talismanic art, which move and speak and act like living men. Cain becomes jealous and envious of Abel and murders him.

Community life further accentuates common thought and is necessary for the preservation of mankind; but with its growth, individuality is again repressed. Through the ever increasing restrictions brought about by unity of purpose and organization, individuality is forced toward the average. Ideas either destructive or constructive must go up or down to the level of common thought. Great leaders,—philosophers, statesmen, and scientists,—have been those who have resisted these equalizing forces. Now and then a voice cries out: "Here am I lone wanderer in endless search of myself. For æons I have been searching from star to star down the ages until I chanced this way. . . I love the idea of equality, fraternity, democracy, but I must soon leave this crowd and wander on until I come to the kingdom of my solitary soul." He who explores ways of thought or action far ahead of his contemporaries must have an inner world in which he passes long and solitary hours. If he be engaged in scientific experimentation, in an unknown land with neither map nor sign post, he may lose his sight as did Bunsen, or his life as did Lazear.

If the development of individuality be ignored one of the greatest forces in the progress of mankind is lost to the world. On the other hand, the principle of collectivism underlies our entire social organization. It develops a general bond of likeness between the one and the many; it makes the individual a part of the whole; it leads to similarity, equality, fraternity, democracy. It enables us to move in companies, regiments, battalions, divisions, and armies. Without it, a nation sinks into oblivion and a world may be lost. Without individualism the same is true. A commander-in-chief, a great field marshal, is as necessary as the army. A million souls submerge their individuality for a common purpose, but each cries out, Where am I going? What am I doing? What I have in myself is moribund. I am physically an automaton, and intellectually boots, boots, boots.

The child accepts life as it is; it sails in a ship over seas that are calm; it knows naught of the larder, ballast or sails; the length of the voyage; the course or the destiny. Its life is in another's keeping; its own life is unknown; nothing stirs from within. The youth thinks of the ship; the voyage; the strange lands which bid him come. Self is beginning to assert itself; something stirs from within. Maturity builds a ship, carefully equips it, and sets forth on an uncharted ocean in quest of a new world. Something within takes possession of the heart and soul and guides every act.

Education is the bringing out of something from within; not the forcing of something in from without. Its emblem was written by an unknown hand on the walls of Delphi—"Know thyself." It is this something within; the personality, the essential self, the individual which must receive greater consideration in our schools. What I have in common with others is best developed by the school. What is mine and mine alone can not go to school with any one but it can be stimulated, intoxicated, liberated.

Let us proceed with the central thought; greater men in medicine through greater liberty in medical education. A medical school is built upon the same general foundation as any other institution. Purpose, products, materials, and methods form the corner stones.

The purpose of the medical school is to train men in the application of scientific methods to the prevention, alleviation, and cure of disease, and to advance medical knowledge in its broadest sense.

The products of medical schools may be considered as belonging to three principal groups: the practitioners, the investigators, and the teachers. A survey of the medical profession at large shows that its eminent men usually may be placed in one or the other of these groups; sometimes in two, but rarely in three. The group of practitioners comprises those whose primary interests are in the alleviation and cure of disease. The group of investigators includes those whose deepest interests are in the causation and prevention of disease. The group of teachers contains those whose principal aims are the dissemination of the methods adopted and the results achieved by the practitioners and the investigators. Lister, Pasteur, and Osler typify the groups.

A few decades ago, the country demanded and the schools furnished, for the most part, but one type of practitioner, and that type was the all-round practitioner. He was obliged to know something of medicine, surgery, and obstetrics, together with dentistry and pharmacy. In addition to these, he was expected to show proficiency as a veterinarian. The conditions of to-day are so different, that the all-round practitioner of to-day would have been a specialist fifty years ago. The cries from the country for general practitioners are heard far and wide but are less and less heeded by the young graduate. A doctor who has had modern training in laboratories and clinics with apparatus and libraries and contact with progressive men, is quite unwilling to leave all these. Moreover he can not come up to dear old Dr. Brown to whom physiognomy revealed more than modern laboratory methods; who did many a successful major operation on the kitchen table, and who thought nursing and a controlled environment entirely superfluous. The ambitious young doctor of yesterday, following the advice and example of his successful seniors, went forth to do an all-round practice for a number of years before entering upon the study of a specialty. Away from libraries, laboratories, clinics and stimulating colleagues, he found little growth or expansion, beyond that indicated by adipose tissue. The ambitious young doctor of to-day who contemplates a career as a specialist dispenses with this hibernating period of two or three years and seeks instead the live atmosphere of the hospital, an assistantship to the master, or a fellowship in some one of our great foundations. The rural districts and small towns will be obliged to adopt something of the same methods that they long ago adopted in securing churches, schools, and factories—they will be obliged to build and equip hospitals if they hope to obtain modern medical service. With the hospital comes the staff which, in turn, forms the basis of the group clinic. Instead of the general practitioner making a complete diagnosis, there is a group of collaborating clinicians, each of whom is an expert in his particular field. The rapid development of the group clinic is creating a situation which must be recognized both by the profession and the schools.

The practitioner of the future, either general or special, not only must measure up in self-reliance, responsibility, and judgment to the practitioner of the past, but also must be better trained and more thoroughly imbued with the investigative spirit.

Each patient presents a problem, the solution of which is more difficult than that in almost any other field of science. While every medical problem must be approached through the avenues of physics, chemistry, or biology, the physician is often baffled at the very beginning of his work by the fact that he is unable to determine which will aid him most. Often he finds that no one of these sciences will solve the problem but that all are involved. Physics may explain the mechanism of joints and muscles; it may aid us in the interpretation of the effects of light, heat, electricity, osmosis, pressure, on living tissues, but it does

not explain, nerve impulses, sensations, memory, or thought. Chemistry may teach us the rates of protein, carbohydrate, and fat metabolism in health and disease; it may help us to know more of the precious vitamines and hormones but it does not tell us why one child resembles the father or mother physically and mentally, while another child does not. Biology may aid us in solving this problem but she, too, is extremely jealous of her secrets. She readily acknowledges that the process of fertilization is essentially the same throughout the animal kingdom, but she teaches us that the processes of regeneration are entirely different in different forms, and cautions us not to infer that a new leg will grow out from the stump of an old one in man as it does in some of the lower animals. She teaches that the organs of seeing, of hearing, of smelling, of tasting, of feeling, are the organs through which these sensations habitually are received. But she warns us not to infer that the loss of one of these special sense organs means an entire loss of that special sense. Our senses overlap to a degree which we little realize; light perception through the skin; sound perception through all parts of the body; color perception through both sound and smell; are a few of the many possibilities as revealed in the lives of Laura Bridgeman, Helen Kellar, Willetta Huggins and others. Deductions from the phenomena presented in these various fields are extremely hazardous and emphasize the necessity of working through the avenues of multiple hypotheses in the interpretation of disease. When this has been said, let us also recall that the names of diseases, of their courses, and of their processes are broad, generic terms, which signify physical, chemical, and biological complexes. Acuteness in observation; precision in experimentation and caution and judgment in deduction are the essentials for the interpretation of disease. They are the A.B.C. of the practitioner of the future.

One of the greatest needs in our medical schools of to-day is the encouragement of students to devote their lives to the study of the causation and prevention of disease. It becomes more and more apparent, as set forth last year by the committee on graduate work, that the medical schools must give opportunity and encouragement for men to develop as research workers. We need no longer argue that reproductive scholarship must be supplemented by productive scholarship. We accept the established fact that the investigative spirit must pervade the atmosphere of the medical school. Frequently a student stands where the roads fork and, as William James puts it, "one branch leads to material comfort, the flesh pots, but it seems a kind of selling of one's soul; the other to mental dignity and independence, combined, however, with physical penury. On one side is business, on the other science." It is not enough for the student to stand in deep perplexity outside the private door of his teacher and whisper that research work is going on inside. He must be invited in, and given time to accept the invitation. It is therefore necessary that some provision be made whereby any student may come more intimately in contact with research methods and ideals than is possible in our medical course of to-day. How far we can organize research is a question. There is no doubt but what to some extent we can create the investigative spirit. At any rate, we can help the young man who evinces this spirit; we can give him time; furnish him with apparatus and books; point the way to fields of investigation; discuss his problems and help him in his experiments. We can not dominate him nor restrain him. We can not force him to work independently or in cooperation; this must depend upon his bent, his personality, his individuality,—genius can not be organized nor can it go to school.

In every medical school there are those who are deeply interested in presenting summaries of the progress made in certain fields of medicine, or in the entire province of medicine. Their object is to sift out and correlate well established procedures. They may be neither practitioners nor investigators in the sense previously mentioned. They are so to speak the editors of medical facts and theories; the compilers; the writers of textbooks; the historians. This group we may designate as teachers or medical journalists. I am fully aware that this group is one created by American institutions

and will doubtless become extinct in time for the simple reason that teaching must be accompanied by thinking; teaching and research are inseparable. The great teacher has always possessed the investigative spirit but may not have been a great investigator. We must, at present make provision for those who wish to prepare for teaching in its broadest sense.

These three types have been designated as they exist to-day. They are generic rather than specific. They possess many attributes in common and may sometimes form a trinity.

The materials to be converted by one method or another into the products set forth are students who enter the medical school with a high school and at least two years of college training. There are no two who have followed the same course of study with the same degree of interest or who have reached the same results. In the high school the student feels his way through a large range of group electives, and often before entering college he has decided that he will major in agriculture, engineering, law, theology, or medicine. In his college work, electives have enabled him to accentuate his choice or perchance to find that his decision was wrong. In both high school and college the student may have inclined toward subjects involving manual training and thereby have acquired keenness of touch and dexterity, or toward music, cultivating the sense of hearing. He may have elected biologic sciences, accentuating observation. He may have turned toward mathematics, physics and chemistry, emphasizing precision in deduction and experimentation. He may have laid special stress on history or languages thus acquiring an excellent memory and facility of expression; or perchance on philosophy thus developing the power of abstract thought. Those of us who come in contact with these men as they enter upon the study of medicine are impressed by their differences in concept, habit and training. He who comes from the land of mighty oceans, forests, and mountains, thinks in larger terms than he who comes from the truck farm. The boy brought up in the country better understands the thought and action of the country folk than the boy brought up in the city. The boy who is reared in the highly commercialized districts of a great city regards an education in quite a different light from the one who is reared in a college or university town. One student is always on time, another is always behind time; one works quickly, another slowly; one is deft, another clumsy; one student retains best what he sees—his memory is visual; another retains best what he hears—his memory is auditory; still another remembers best what he reads—his memory depends on word association. One mind stores up isolated impressions and facts—it is analytic; another arranges impressions and facts in groups—it is synthetic. Will the student who is slow and clumsy ever make as efficient a surgeon as the one who is quick and deft? Will the one whose memory is auditory, or depends on word association, ever succeed in surgery as well as another who is able to visualize the positions and relations of organs in the body? Will the student who has an untrained ear ever make as efficient an internist as the one whose keenness in sound perception and discrimination enables him to differentiate between normal and abnormal sounds in the lung or heart? Is the one which an analytic mind as capable of interpreting a syndrome as another whose mind is synthetic? It is beyond question that the men who enter the medical school at the age of 22 or 23 years are quite unlike in their mental equipment and this fact must be taken into account in the medical curriculum.

The method of the medical school is the curriculum; around it centers, to a large extent, the resources of the school, and through it are expressed the principles and concept of medical education. The curriculum of half a century ago was probably the best that could be devised to meet the needs of the profession and schools of that day. From an economic point of view, it was highly advantageous; one teacher could lecture to a large number of students and was entirely relieved of the time consuming instruction to small groups and individuals. It was an excellent mechanism for turning out one type of general practitioner. While it served in part as an intellectual pathway, it also functioned as a "straight jacket." It kept the students so busy that they could not destroy

much property nor throw out many professors. To-day the conditions are entirely different. The financial situation has changed so that the school is no longer a recipient but a donor. The students are better trained both in behavior and intellect and are more eager for instruction. Many teachers are on a vocational basis and are able to give more time to instruction. Moreover, the medical school no longer looks to a single product, but to many products. The fixed curriculum of half a century ago will not meet the conditions of to-day, yet, in principle, it has remained unchanged. Our national organizations dealing with medical education have recognized and emphasized the need of a more liberal curriculum but have not adopted measures that materially assist the medical school in the development of such a curriculum. The fixed curriculum is so deeply rooted, so widely spread and so thoroughly fostered by standardizing bodies and educational institutions that state examining boards are rapidly adopting or creating such curriculums as the basis for medical licensure. "Eight months in each of four separate calendar years," devised for the improvement of medical education became a serious obstacle to patriotic service during the late war, and is no less an obstacle to education at the present time. A curriculum covering 4,000 prescribed hours is another mechanism to protect and advance medical education but it has defeated thinking. Medicine and medical specialties, 900 hours; surgery and surgical specialties, 648 hours; obstetrics and gynecology, 216 hours; are artificial divisions proposed by the medical educational bodies as a means of insuring better trained physicians and of eliminating bad medical schools, but these regulations have resulted in the state boards going one step further with the same good intent. But what a handicap has followed as a result of these measures. One state requires 170 hours of general pathology, another 240, another 250, and still another 270. Like variability is found in practically all the subjects in the state board curriculums. Certain peculiar requirements are exacted by some of the state boards. For example, one says in substance, either teach 60 hours of electro-therapeutics or your graduates can not practice in our state.

The day is not far distant when the schools must either incorporate in their curriculums the particular requirements of each state board curriculum or find that their graduates are not qualified to practice in these states. To incorporate these requirements means an enormous time expansion and this is impossible. The schools are thus approaching an impasse of their own creation and some remedy must be found. The one obvious solution is the creation of an elastic curriculum. The students in entering the medical school with a fixed curriculum are beginning a four-year program that requires all to do essentially the same kind and the same amount of work at the same time and in the same way. They are leashed together, made uniform in action and thought like the rowers in a great galley; shackled hand and foot, heart and soul, with chains of our own forging. It follows that the more uniform the special senses and intellectual processes, the more efficient becomes such a curriculum. To reach its maximal efficiency, we must revamp and equalize the special senses and intellectual processes,—but is this education?

The fixed and congested curriculum of to-day must give way to an elastic curriculum which is adjustable not only to these perplexities but also to instructional resources, clinical resources, and to the growth of medical science. It must provide for collective teaching; cooperative study and individual study.

Alexander Bain tells us that in the Scottish universities prior to the eighteenth century the quadrennial arts course was conducted by so-called regents, each of whom carried the same student through all the four years. In a rectorial address to the students of Aberdeen University, in 1882, he said: "You the students of arts, at the present day who encounter in your four years, seven faces, seven voices, seven repositories of knowledge, need an effort to understand how your predecessors could be cheerful and happy confined all through to one personality; sometimes juvenile, sometimes senile, often feeble at his best." Contrast this with the condition to-day, when seventy faces, seventy voices, and seventy personalities are encountered by the medical students in the four years of their course. To the

single instructor the student could carry his entire intellectual possessions; to each of the seven, one seventh; to each of the seventy, he can carry but one seventieth. But what instructor realizes this and is willing to accept his proportion? Each demands more than the student can give, and the student under this tremendous pressure loosens his hold on the get-something idea, adopts the get-by methods, and revises his ethical principles accordingly.

Probably no field of science is undergoing a more active fermentation than medical science, with the splitting off of new segments; the discarding of certain subjects; and the addition of new subjects. Just as physiology and pathology split off from anatomy, so biochemistry is outgrowing physiology; bacteriology is asserting its independence of pathology; pediatrics and neurology, otolaryngology and ophthalmology are attaining independence from general medicine and surgery. Owing to the increase in entrance requirements, certain subjects like chemistry, embryology, histology and comparative anatomy are being shifted from the medical course to the premedical course, while other subjects like osteology, bone modeling, etc., have fallen by the wayside. Again, there is going on a continual importation of subjects from the outlying fields of investigation. Immunology, Roentgenology and parasitology have been brought into the curriculum from these outlying fields. The schools that are most actively engaged in the exploration and investigation of borderland subjects find greatest difficulty in holding to a fixed curriculum.

The clinical resources of one school may be quite unlike those of another. One is favorably situated for the study of tropical diseases, another is able to utilize a great tuberculosis sanatorium, another a great psychopathic institute. The school should be able to adjust its curriculum to these resources. If in South Africa, study sleeping sickness in the clinic, in the class room, and in the laboratory. If in Panama or Louisiana, emphasize, if you wish, malaria; if where cretanism abounds, study it, teach it and think it. While one school may thus emphasize this or that particular line of study, all are studying disease, and the underlying principles of disease prevention and control are not distributed geographically. Upon the proper certification that a student has had four or five years training in a good medical school should rest his qualification to practice. If it be expedient to protect the public by some form of state or national examination such examination should be directed solely toward determining the student's ability to work and think in terms of disease prevention and control.

The principle of collective teaching in all education is based upon the assumption that all human beings possess certain resemblances both physical and mental; otherwise we could not speak of them as a group. Each person possesses more or less of every ordinary human power. Our senses of feeling, tasting, smelling, hearing and seeing are similar; their actions and interactions upon an inherited substratum are reflected in thinking, and modes of thought run along fairly parallel lines. Collectivism stimulates a spirit of emulation; of comparative evaluation of mental assets both quantitative and qualitative. It arouses a sense of power which enables a member of a group to overcome obstacles which would defeat him if he were alone. This is forcibly illustrated by the heroic deeds of the soldier when inspired by the common purpose of the group. The status of the medical profession demands many elements of collectivism. There must be developed in the medical students a fraternal sympathy; a spirit of mutual consideration, and a basis for disciplined, or expert, cooperation. There is a fairly common substratum in each subject, in each great division, and in the curriculum as a whole, which can be presented collectively, and whether or not this be the method of the future, it must be the method of the present because it is an economic necessity. These are some of the considerations which justify class lectures, class demonstrations, class experiments and class examinations. It must not be inferred, however, that it likewise justifies the existence of the present division of students into freshman, sophomore, junior and senior classes. This grouping is a menace to education and should disappear as soon as possible, especially in the medical school.

The spirit of cooperation between faculty and students in medical training is one of greatest value to the student, not only for the school period, but throughout his entire life. In order to develop this spirit, we should determine as far as possible the special assets of each student at the time he enters the medical school, and ever keep in mind his adaptability for certain kinds of work. Much can be learned through contact afforded by laboratory work and through the seminar. This should be supplemented by a knowledge of his home life, his living conditions and his social habits. Through careful observation and inquiry, we must obtain as clear a picture of the student's individuality as is possible. With this as a guide we should help him to place his assets where they will yield the greatest returns. Experience teaches that most students, at the end of the second or third year of the medical course, have decided whether they wish to lay equal emphasis on medicine, surgery and obstetrics, fitting themselves for general practice, or to give some emphasis to one, fitting themselves for a special field. If, in the judgment of the faculty, the student's selection is wise, he should be permitted to accentuate his choice. In the fourth year the student should be allowed a further latitude which will permit him again to accentuate the all-round training in medicine, surgery and obstetrics, or to lay further emphasis on one of these. In the fifth year, he should be given the liberty to round himself out for general practice as an interne, or to add to his special training, or to do independent work in research. Collective teaching and cooperative study are both necessary but they both are drawn into a common vortex unless supplemented and invigorated by individual study.

Individual study alone starts the waves which roll on and on toward the unseen and unknown shore. Working in harness is most excellent for the development of the team, but the freedom of the fields is necessary for the growth of the individual. What an inspiration comes through the exploration of the limitless fields! What a thrill comes when the individual receives a new interpretation or new revelation of nature's laws! How hopeless to read a description of the country one is about to explore. It is known only by exploring it. Individuality derives strength from the history of science, its workers and their work; but no record or experience coincides with it. They are as guide posts which disappear at the frontiers of science and individuality must wander on alone. The light from the north star may direct its footsteps but the light which comes from the soul spurs it on. The traditional home of individuality is in the university, and here is the one place where it should be fostered and encouraged. It is fair to presume that in each of our medical schools there are to-day students of great potentiality who need but the stimulus and opportunity to become leaders in science. How shall they be given the opportunity. One of the simplest of the initial steps to be taken would be to grant them the privilege of electing a certain portion of their work both quantitatively and qualitatively. The privilege of adjusting study to capacity should be restored. It was distinctive of the earlier ages and each successive generation has lessened the privilege. The students of our day are expected to know more and must consequently attempt to learn more than the most brilliant intellectual leaders of the past, who would be content to-day with the schooling of Horace, of Shakespeare or Darwin. Where they learned one thing we are attempting to learn a half dozen. They acquired knowledge; we attempt to. We can not keep the medical students marching in the trodden paths of their predecessors until weary and heartsick they complete the march, only to find that they have also acquired mental debility on the way. We must encourage them to forsake the trodden paths, to break tradition when tradition is outgrown, and to explore the unknown fields. Individuality can never be limited to the mechanism of public order, either within or without the school. Life is bigger, it asks for more. There is only one way to develop strong men, and that is by helping them to become independent thinkers. Electives are the stepping stones to independent thought, and independent thought is the threshold of knowledge.

Throughout nature there are many beautiful pictures of collective and individual effort.

Who can but envy the ideal presented in the life of the wild honey bee that belongs to the swarm and works with her companions for a common purpose. Her coming and going are regulated by no schedule or master. She goes through the forests, along the streams, over the meadows, from flower to flower, gathering nectar from wherever it can be found. Ever going, ever returning, she not only increases her particular store, but enlarges that of the swarm. Beyond and above all these, and all unknown to her, she gives to mankind greater blessings in flowers and fruits.

Let us give to the student opportunity and encouragement to seek truth wherever it can be found. In bringing truths together he builds not only for himself but also increases the common fund of useful knowledge. Beyond and above these, he helps to build a great fund of knowledge which will illuminate life in the years to come.

A. C. EYCLESHYMER

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HYDRA IN LAKE ERIE

WE seldom think of Hydra as of outstanding economic importance. However in this connection some interesting data were obtained by the writer during the summer of 1920 while staying at a pound-net fishery on the north shore of Lake Erie near Merlin, Ontario. The fishery is located about midway between Rondeau and Point Pelee, and from it are operated 20 pound-nets in four strings, 5 pound-nets in a string. The strings are approximately three miles apart and this would mean about nine miles from the most easterly string to the most westerly. In midsummer all the nets were taken out of the lake, some replaced from a reserve stock, the others simply reset after being washed, dried, mended and tarred. This midsummer cleaning is necessary because of the algal and other growths which accumulate on the nets making them heavy as well as putting considerable strain on the nets, especially in stormy weather, through the obstruction of the free flow of water through the meshes.

All of the nets when lifted in late July and early August were loaded with a very conspicuous brownish-orange growth in addition to the bright green algal growths. At first sight diatomaceous ooze or a bacterial production was suggested but microscopic examination showed it to be composed of innumerable living Hydras. The nets were lifted into the characteristic flat-bottomed pound-net boats and brought to the dock. The boats were anchored 100 to 150 yards from the dock and the nets dragged through the water to cars on the dock in order to wash off some of the loose material, especially mud. In addition to the mud many Hydras were washed off and these gave to the water a brownish-orange color quite distinct from the lighter color of the mud. The bottoms, seats, etc., of the boats were covered with Hydras to the depth of from ⅛ to ¼ inches and a quart jar was quickly filled by simply running a hand along the seats. A fisherman eight miles to the west and another seven miles to the east reported Hydra in apparently equal abundance. This means a distribution of at least fifteen miles along this part of the shore. The beach is sandy to gravelly with some large stones. Very little life was found on the bottom out as far as one could wade. However out beyond the region of strong wave action there must be places of attachment for the Hydras other than the nets in order to account for the existence of the species from one fishing season to another, since in 1920 they had not reached sexual maturity by the first week in December when the nets were removed for the season.

Specimens of this Hydra were submitted to Professor Frank Smith of the University of Illinois who kindly stated that they without doubt were *Hydra oligactis* Pallas although absolute determination could not be made in the absence of gonads. He stated that the large size and numerous buds indicated optimum conditions of food and temperature.

Fishermen had frequently spoken about a poisoning which often affected them while handling the nets during the process of cleaning and mending. They said this occurred chiefly after the nets had dried and were covered with a fine dust which they called tar dust. No poisoning was observed during this

summer but the men stated that their hands and faces became inflamed and swollen especially if there were any cuts. The eyes were often affected also. Lack of time prevented carrying out any experiments but it seems quite probable that the poisoning could have been traced to the Hydras. The dust was composed of dried sediment and organic matter and certainly must have contained a high percentage of Hydra remains.

This account has been written to call attention to an economic problem in relation to the fishing industry, which awaits study. There would appear to be at least four points for investigation.

(1) The amount of interference and injury caused to the nets by these great growths.

(2) The question of the poisoning of the fishermen.

(3) Do these Hydra destroy young fish to any appreciable extent in open water? Beardsley in 1902 in Bull. U. S. Fish. Comm., vol. XXII, pp. 157-160, recorded the destruction of trout fry by Hydra in a hatchery at Leadville, Colo.

(4) To what extent do these immense numbers of Hydra reduce the entomostracan food supply of young fish and of mature fish such as the ciscoes? The latter in Lake Erie feed almost exclusively upon *Entomostraca* and if the Hydra are as abundant throughout the lake as they are along the fifteen miles of shore as described above they must be very serious competitors of these fish in the matter of food.

Since the above was written Professor Paul S. Welsh of the University of Michigan has informed me that he has been making a special study of Hydra in the Lakes of Northern Michigan.

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A MOSQUITO ATTRACTANT

CERTAIN facts regarding the possibility of attracting mosquitoes were disclosed in the course of experiments made in 1919 which may have a bearing on mosquito control. Press of other work has prevented further development of this project and the following notes are offered for the consideration of those who may care to give the matter further attention.

A number of possible attractants were tested. Among these were crude mixtures of the components of perspiration and of blood which seemed to produce faint, erratic response from the mosquitoes, but it was found that a degree of warmth somewhat above that of the surrounding air was highly and consistently attractive to a certain percentage of these insects. Thus a joint of stove pipe placed in the woods and warmed somewhat by an alcohol lamp, attracted about as many mosquitoes as were attracted by persons in the vicinity. It must be said, however, that in all of our field tests of this attractant the mosquitoes were scarce.

In most of the laboratory experiments with heat *Culex pipiens* was the species used and the insects were liberated at will, as bred, into a cage about 20 x 20 x 15 inches square having the top and three sides of cheese-cloth, the bottom of wood, and the fourth side of glass for observation. The source of heat was water in a glass flask which was heated by an alcohol lamp. Air bubbled through this water through tubing by means of a pump in connection with a gas bag and was afterwards delivered to a funnel the open face of which, covered with cheese-cloth, was placed very near but not touching the side wall of the mosquito cage. A thermometer was inserted in this funnel.

As the temperature rose to a point where it exceeded somewhat that of the surrounding air a sinister beard-like growth would appear on that part of the cheese-cloth wall of the cage covered by the mouth of the funnel. This was produced by the beaks of the mosquitoes which were pushed through the cloth with great persistence as long as the current of warm, moist air was kept within certain limits of temperature. There seemed to be no specific optimum temperature but the maximum response occurred between 90 and 110 degrees Fahrenheit which represented temperatures from 15 to 30 degrees higher than that of the surrounding air. When the temperature reached 120 degrees less interest was displayed and at 140 degrees the mosquitoes were entirely dispersed.

At temperatures below 85 degrees there was very little response if any.

A comparatively small number of the mosquitoes reacted positively to heat at any one time; thus with 300 mosquitoes in the cage perhaps not more than fifteen or twenty would be attempting to feed at the height of the reaction. Whether the same individuals were concerned in each of a series of such responses or whether various individuals at different times took part, was not determined.

In nearly all of these experiments, which were made in an open insectary, no attempt was made to eliminate the odor of the observer but in some tests made in a closed room in an air-tight apparatus the mosquitoes responded in the usual manner when air was drawn from outdoors through a long tube. It is interesting to note, however, that when the breath was bubbled through the water instead of the usual current of air a decided increase of interest on the part of the mosquitoes was manifest. The admixture of various amounts of carbon dioxide with the air stream did not increase the interest over that shown for undiluted air.

In one series of experiments a hole about two inches square was cut in the lid of each of two pasteboard boxes which were exactly alike. These holes were covered with cheesecloth and a layer of absorbent cotton was supported immediately beneath this cloth. In one box the cotton was moistened with cool water while in the other it was moistened with hot water and was supported by a bottle containing hot water. When these two boxes were exposed in the mosquito cage considerable numbers of the mosquitoes would visit the warm box and attempt to feed while they paid no attention to the cool box.

Several types of traps in which heat was employed as an attractant were tested in the field and mosquitoes could be caught in even the crudest of these traps but the insects were also able to escape from all of them, displaying decidedly more ingenuity in this respect than is shown by the house fly. Experiments with more complicated traps were cut short owing to the entire disappearance of mosquitoes.

It was also found that mosquitoes in cages fed readily upon a solution of potassium arsenite in sweetened water and that this material was highly toxic to them. This suggested the use of such a poisoned bait in heat traps and traps were also devised in which the insects might be destroyed upon entering a chamber containing potassium cyanide. Neither of these agencies could be tested in the field.

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BUREAU OF ENTOMOLOGY,
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SCIENTIFIC EVENTS

HEINRICH SUTER

ON March 17 there passed away Heinrich Suter, for many years gymnasialprofessor in Zurich, Switzerland, and a noted student of the history of Arabic mathematics and astronomy. For thirty years he was active as a translator and commentator of Arabic authors. The twenty years preceding 1892, when his first distinctly Arabic research was published, were years of preparation, during which he published a history of the mathematical sciences and a number of papers on mathematics during the Middle Ages in Europe. Most of his shorter articles appeared in the *Bibliotheca Mathematica* and in Schlömilch's *Zeitschrift für Mathematik und Physik*. As regards the quality of Suter's extensive studies of Arabic science it is enough to say that they are highly respected in an age when higher standards of historical accuracy are being established in Europe.

Suter was born on January 4, 1848, at Hedingen, near Zurich; he studied in Zurich and Berlin, and took his doctorate in 1872.

FLORIAN CAJORI

THE CALCUTTA SCHOOL OF TROPICAL MEDICINE

THE *British Medical Journal* states that the School of Tropical Medicine and Hygiene and the Carmichael Hospital for Tropical Diseases at Calcutta were opened by Lord Ronaldshay, governor of Bengal, on February 4. In the issue of December 3, 1921 (p. 957), it was noted that the School of Tropical Medicine and

Hygiene had begun work in the previous November, when a telegram of congratulation, announcing that the first lectures had been given, had been sent by the director, Lieutenant-Colonel J. W. D. Megaw, I.M.S., to Sir Leonard Rogers, who played the leading part in the inception and carrying through of this great enterprise. In the *Journal* of April 23, 1910 (p. 1010), the very great advantages which Calcutta offered for the establishment of a school of tropical medicine were pointed out; not only is the variety of clinical cases illustrating tropical diseases unsurpassed, but there is an excellent hospital and medical school, with a highly qualified staff accustomed to teaching, and for the greater part of the year the climate is no drawback. Some eleven years ago the general scheme for the school of tropical medicine was worked out by Sir Leonard Rogers, but its subsequent history has been marked by many delays, not a few of them to be traced to the war; the foundation stone was actually laid by Lord Carmichael, governor of Bengal, in February, 1914. The hospital has accommodation for about 100 patients, European and Indian, while the school has chairs of tropical medicine, pathology and bacteriology, protozoology, pharmacology, serology, public health, and chemistry, to which appointments have already been made; professors of hygiene, entomology, and biochemistry have still to be appointed. In addition, there are assistant professors of the chief subjects, and a number of special research appointments have been made. The nucleus of a reference library has been formed, mainly by gifts from Sir Leonard Rogers. In the report of the director for 1921 it is stated that classes will shortly be opened for the diploma in public health of Calcutta University; classes for the diploma in tropical medicine have already begun. The director considers that the result of the first year's working has entirely removed the doubts and fears which assailed him when he entered on his responsible duties. Considerable progress has also been made in the research laboratories, and reports have been published of work in connection with leprosy and kalazar and filariasis, and on the work of the hookworm laboratory.

FIELD WORK OF THE MUSEUM OF ZOOLOGY OF THE UNIVERSITY OF MICHIGAN

During the next fiscal year, which begins on July 1, the Museum of Zoology of the University of Michigan will carry on field work in Michigan, California, Washington, Oregon, North Dakota, Tennessee, Curacao, Panama, Mexico, Brazil and British Guiana.

Fifteen persons will be in the field: Carl L. Hubbs, Norman A. Wood, Lee R. Rice, Mina Winslow, Frederick M. Gaige, Helen T. Gage, Theodore H. Hubbell, and Alexander G. Ruthven, of the museum staff, and Crystal Thompson (Amherst College), Robert Hatt (University of Michigan), Rolland Hussey (Bussey Institution), Horace B. Baker (University of Pennsylvania), Thomas L. Hankinson (Michigan State Normal School), and Jesse Williamson and John Strohm of Bluffton, Indiana.

The work in North Dakota will be done in cooperation with the North Dakota Biological Station, of which Professor R. T. Young is director.

The work in western Brazil is under way and is being directed by Jesse Williamson. The party will remain in the field until sometime next year.

BRANCHES OF THE PSYCHOLOGICAL CORPORATION

Executive committees for branches of the Psychological Corporation have been organized in several states as follows:

Massachusetts: William McDougall, *chairman;* Herbert S. Langfeld (Harvard University), *secretary;* Edwin G. Boring, W. F. Dearborn, W. R. Miles, Daniel Starch, F. L. Wells.

Pennsylvania: W. V. Bingham, *chairman;* E. K. Strong, Jr. (Carnegie Institute of Technology), *secretary;* Clarence E. Ferree, Francis N. Maxfield, B. V. Moore, J. H. White, Lightner Witmer.

Ohio: George F. Arps, *chairman;* Harold E. Burtt, (Ohio State University), *secretary;* B. B. Breese, B. R. Buckingham, Henry H. Goddard, H. M. Johnson, Garry C. Myers.

Michigan: W. B. Pillsbury, *chairman;* H. F. Adams (University of Michigan), *secretary;*

S. A. Courtis, C. H. Griffitts, G. M. Whipple, Helen B. T. Wooley.

Illinois: Walter Dill Scott, *chairman;* Frank N. Freeman (University of Chicago), *secretary;* Madison Bentley, Elmer E. Jones, Charles H. Judd, E. S. Robinson.

In addition to the branches that have been definitely established by the psychologists of the states named and approved by the executive committee of the directors of the corporation, other branches are in course of organization.

All members of the American Psychological Association who are interested directly or indirectly in the applications of psychology, as well as other competent psychologists approved by the branches, may be members of the branches. Correspondence in regard to the Psychological Corporation in the states named should be addressed to the secretaries of the executive committees.

GEOGRAPHICAL MEETING IN NEW YORK CITY

THE sixth joint meeting of the American Geographical Society and the Association of American Geographers will be held in New York, Friday and Saturday, April 28 and 29. The sessions will be held at the Exhibition Room of the American Geographical Society, Broadway at 156th Street. Professor Harlan H. Barrows, president of the association, will preside at the sessions. The joint meeting will be called to order on Friday morning by Mr. John Greenough, president of the American Geographical Society.

The Belleclaire Hotel, at the corner of Broadway and 77th Street, will be headquarters for association members. The American Geographical Society has against invited the members of the association and invited speakers to be their guests from Thursday afternoon to Saturday noon. Non-members, as always, will be cordially welcomed to all program sessions.

Space in the Exhibition Room has been reserved for an exhibit, by members of the association of new maps and diagrams. Members are urged to send any geographical material they desire to have displayed in advance of the meeting. The noon hour each day gives an opportunity to discuss materials on exhibit, an opportunity that has proved very helpful in the past.

The society's building can be reached by the uptown subway train marked Broadway and Seventh Avenue Express, Van Cortlandt Park, or Dyckman Street, or 215th Street, from any Broadway station. The 72nd Street subway express station is five blocks south of the hotel; the 79th Street local station is two blocks north. At certain hours change must be made from a local to an express train at 96th Street.

The program is as follows:

FRIDAY MORNING SESSION

Vilhjalmur Stefansson: Colonizing the lands beyond the treeline.

Alfred H. Brooks: The future of Alaska.

H. N. Whitford: Present and prospective use of tropical lands and tropical forests as illustrated by the Philippines.

FRIDAY AFTERNOON SESSION

Oliver E. Baker: The problem of land utilization and its geographic aspects.

Carl O. Sauer: The problem of the cut-over pine lands of Michigan.

Hugh H. Bennett: The soils of the Southeastern States and their utilization.

FRIDAY EVENING

Round Table Conference: Methods and problems in the study of land utilization.

SATURDAY MORNING SESSION

E. F. Gautier (University of Algiers): Native life in French North Africa.

H. A. Brouwer (Delft Technical Institute); Physical features of the Dutch East Indies.

C. W. Bishop: Geographical factors in the early culture development of Japan.

SIGMA XI AT McGILL UNIVERSITY

THE thirty-sixth chapter of Sigma Xi was installed on April 13 at McGill University, Montreal. This event marks an epoch in the society's progress inasmuch as the McGill chapter is the first one to be established outside the United States. It is expected that there will soon be other petitions from the Dominion, and that Canadian institutions will take an active part in the society's affairs.

The charter membership of the new chapter comprises 41, including representatives of both pure and applied science and medicine. Four of the members are also fellows of the Royal

Society, a somewhat new distinction to come to Sigma Xi.

The installation ceremonies were conducted by Dr. Henry B. Ward, president of Sigma Xi, and Dr. Edward Ellery, secretary of the national organization. After the routine business had been transacted, Dr. Ellery delivered the charge to the new chapter, tracing the history of the society since its inception at Cornell in 1886, and outlining the gradual evolution of its ideals and methods of functioning.

The installation dinner was held in the evening at the Mount Royal Club. The chapter had as its guests Sir Arthur Currie, principal of the university; Dr. Gordon Laing, dean of arts and chairman of the Graduate School; Mr. W. M. Birks, of the board of governors; Dr. Georges Baril, of the Université de Montréal; Mr. E. J. Archibald, managing editor of the Montreal *Star,* and Mr. R. L. Hamilton, president of the Students' Council, as well as Dr. Ward and Dr. Ellery. The toast to McGill University was responded to by Sir Arthur Currie, that to Sigma Xi, by Dr. Ward in an inspiring address, and that to the new chapter, proposed by Dr. Ellery, by Dr. F. D. Adams, vice-principal and dean of applied science.

The officers of the McGill Chapter are:

President: Dr. W. W. Chipman.

Vice-presidents: Dr. A. S. Eve. F. R. S., Dr. J. Bonsall Porter.

Secretary-treasurer: Professor R. DeL. French.

Executive committee: Dr. H. G. Barbour, Professor F. E. Lloyd, Dr. D. A. Murray.

The secretary expresses the hope that no member of Sigma Xi may pass through Montreal without giving the McGill Chapter an opportunity of welcoming him to the city and of assisting him in every possible way.

THE SALT LAKE CITY MEETING

The summer session of the American Association for the Advancement of Science to be held in conjunction with the sixth annual meeting of the Pacific Division of the Association at Salt Lake City, June 22 to 24, 1922, promises to be a very successful meeting.

Salt Lake City offers many advantages as a meeting place. The center of a rich agricultural and mining section, it has large and important commercial and manufacturing interests. But it is perhaps chiefly famed for its scenic attractions drawing every year thousands of tourists by auto and railway from all parts of the country. The opportunity will be seized by many who will wish to combine a pleasure trip to one of the most interesting sections of the west with the advantages of a scientific meeting. Here will be met delegates from the educational centers of the Pacific Coast as well as from the middle western and eastern states. Many men active in science who have not found it possible to attend the eastern meetings will be at Salt Lake City. Contacts and relationships will be established that will widen the horizon of those attending and prove of lasting benefit.

The hosts of the Salt Lake City meeting will be the University of Utah, the Utah Academy of Sciences, the Utah Agricultural College and the Brigham Young University. Arrangements will be made for the comfort and entertainment of visitors. The meeting will be held under the auspices of the Pacific Division of the Association. Dr. Barton Warren Evermann, the president of the Pacific Division, American Association for the Advancement of Science, will preside at the general sessions and will deliver the presidential address at the opening session on Thursday evening, June 22. He will speak on "The conservation and proper utilization of our natural resources."

An outstanding feature of the meeting will be a symposium on "The Problems of the Colorado River." The great reclamation project which has for its object the utilization of the waters of the Colorado River has already attracted wide attention. It is proposed to consider in this symposium the scientific aspects of the problems involved. The arrangement of the symposium is as follows:

1. General description of the Colorado River: Mr. E. C. La Rue, hydraulic engineer, United States Geological Survey, Pasadena, California.

2. Archeology of the Colorado River Basin: Professor H. R. Fairclough, Stanford University, California.

3. Geology of the Colorado River Basin: Dr. Frederick J. Pack, Deseret professor, department

of geology, University of Utah, Salt Lake City, Utah.

4. The conservation of the waters of the Colorado River from the standpoint of the Reclamation Service: Mr. Frank E. Weymouth, chief of construction, United States Reclamation Service, Denver, Colorado.

5. The interstate and international aspects of the Colorado River problem: Dr. C. E. Grunsky, vice-president of the Pacific Division, American Association for the Advancement of Science, San Francisco, California.

The preliminary announcement of the meeting will be issued shortly to members with further details of the meeting.

While none of the sections of the national association will arrange to hold sessions at this summer meeting the various fields of science will be represented in the meetings of the affiliated societies of the Pacific Division. Those scheduled to hold meetings at Salt Lake City are:

The American Physical Society.
The American Meteorological Society.
The American Phytopathological Society, Pacific Division.
The Ecological Society of America.
The Society of American Foresters.
The Cooper Ornithological Club.
The Pacific Coast Entomological Society.
The Pacific Slope Branch, American Association of Economic Entomologists.
The Plant Physiologists.
The Utah Academy of Sciences.
The Western Psychological Association.
The Western Society of Naturalists.

SCIENTIFIC NOTES AND NEWS

THE degree of doctor of science will be conferred in May by Liverpool University on Sir Charles Sherrington, Waynflete professor of physiology at the University of Oxford, president of the Royal Society and of the British Association for the Advancement of Science.

THE honorary degree of doctor of science has been conferred on Sir Thomas Muir by the University of Cape Town, in recognition of his researches in mathematics and mathematical history. Sir Thomas Muir was superintendent-general of education for Cape Colony from 1892 to 1915.

THE University of Dublin will confer the honorary degree of master of surgery upon Dr. George E. Armstrong, professor of surgery at McGill University, Montreal.

PROFESSOR EDWIN G. BORING, of Clark University, gave a lecture at Wellesley College on April 18, on "The language of the emotions."

DR. MAX PLANCK, professor of mathematical physics at Berlin, has been elected a foreign member of the Swedish Academy of Sciences, Stockholm.

IN order to secure scientific data on the value of moving pictures for use in teaching, the Commonwealth Fund, of New York, has given $10,000 for the use of Professor Frank N. Freeman, of the University of Chicago, in the systematic study of the educational value of various kinds of pictures.

At the recent meeting of the German Microbiologic Society, the annual prize from the Aronsohn Foundation, amounting to 25,000 marks, was awarded to Dr. J. Morgenroth, professor of bacteriology at the University of Berlin and chief of a department in the Koch Institute.

DR. R. D. CARMAN, of the Mayo Foundation, has been elected an honorary member of the Roentgen Society of London.

SIR GERALD EDWARD CHADWYCK-HEALEY, Bt., has been appointed a member of the Royal Commission on Awards to Inventors, to fill the vacancy caused by the resignation of Lord Rayleigh.

DR. C. S. MYERS has resigned from the directorship of the psychological laboratory of the University of Cambridge in order to devote his whole time to the work of the British National Institute of Industrial Psychology.

FREDERICK W. SPERR, JR., chief chemist of the Koppers Company, Pittsburgh, Pa., has been awarded the Beal medal by the American Gas Association, in recognition of his work and paper, presented at the convention of the organization last November, entitled "The Seaboard Liquid Process of Gas Purification."

AT a meeting held in Chicago on April 7, a Chicago Association for the Relief and Prevention of Heart Disease was formed to undertake the type of work carried on by similar

organizations in New York and Philadelphia. The following officers were elected: *President,* Dr. James B. Herrick; *vice-president,* Dr. R. B. Preble; *secretary,* Dr. Sidney Strauss; *treasurer,* Frank O. Hibbard.

The sixth annual clinical session of the American Congress on Internal Medicine held in Rochester, Minn., April 3 to 6, was attended by about three hundred physicians. Dr. Sydney R. Miller, of Baltimore, was re-elected president, and Dr. H. S. Plummer, of Rochester, first vice-president of the organization.

Professor Harold E. Babcock, of Cornell University, has sailed for Bermuda at the request of the Colonial Government, and will remain there a month to assist the agricultural population of the islands to increase their efficiency in the production and distribution of their crops.

The Entomological Club of Madison (Wisconsin) arranged for a radio phone lecture on "Bugs and Antennæ" by Dr. E. P. Felt, state entomologist of New York, sent out by the broadcasting station of the General Electric Company at Schenectady on April 24. Madison is well within the range of this station with fair conditions and the lecture could therefore be heard over much of the eastern United States and Canada.

Dr. C. H. Mayo delivered the Joyce lecture in neurologic surgery before the Academy of Medicine at Portland, Oregon, and the Jerome Cochran lecture before a meeting of the Medical Association of the State of Alabama at Birmingham.

Sir Thomas Lewis will deliver the Noble Wiley Jones lectures under the auspices of the medical school of the University of Oregon between May 15 and 19. The lectures will deal with auricular fibrillation, quinidine and digitalis.

Dr. P. Chalmers Mitchell gave two lectures during March at the Royal Institution on "The cinema as a zoological method."

The Oxford Romanes lecture for 1922 will be delivered on May 24 by Professor A. S. Eddington, Plumian professor of astronomy at Cambridge and president of the Royal Astronomical Society. The subject will be "The theory of relativity and its influence on scientific thought."

Lingan Strother Randolph, consulting engineer and professor of mechanical engineering at the Virginia Polytechnic Institute for twenty-five years, died on March 7, at the age of sixty-three years.

George Ballard Mathews, F.R.S., who was lecturer in pure mathematics and then professor of mathematics at the University College of North Wales, Bangor, from 1884 to 1896, has died at the age of sixty-one years.

The death is announced, at the age of fifty-four years, of Professor Emil Heyn, director of the Kaiser Wilhelm Institut für Metallforschung, Berlin-Dahlem.

A fellowship at the University of Manchester for the encouragement of research in preventive medicine has been instituted in memory of the late Auguste Sheridan Delépine, professor of public health and bacteriology in the university from 1891 to 1921.

The John Macoun Memorial Committee of the Ottawa Field Naturalists' Club announces that, as the number of copies to be issued of the autobiography of the late Professor John Macoun, naturalist to the Geological Survey of Canada, is limited, orders, with or without the subscription price of $3.00, should be sent in by May 15, addressed to Mr. Arthur Gibson, treasurer, John Macoun Memorial Committee, Birks Building, Ottawa, Canada.

The *Journal of the American Medical Association* says in regard to the centennial of the birth of Pasteur, who was professor of chemistry at Strasbourg from 1852 to 1854, that two celebrations are planned in that city, one on the exact date, and another, with great ceremony, on June 1, 1923, when an exhibition will be opened to demonstrate the progress that has been realized in consequence of Pasteur's discoveries, and the Pasteur monument will be unveiled. Professor Borrel, 3 rue Koeberlé, Strasbourg, is in charge of the exposition. The Academy of Medicine has decided to devote one of its sessions in honor of the work of Pasteur. As the Pasteur Institute intends to commemorate this anniversary on the exact date, December 27, 1922, the Academy of Medi-

cine has chosen December 26, the eve of the Pasteur Institute's celebration, in order that the same guests may participate in the two ceremonies. At the session will be presented data showing the progress accomplished since Pasteur's days in general biology, medicine, surgery, obstetrics, veterinary medicine and hygiene. Members of the academy who have been chosen to deliver addresses are: Widal, medicine; Delbet, surgery, Wallich, obstetrics; Barrier, veterinary medicine, and Calmette, hygiene.

THE United States National Museum has recently secured by purchase, through the cooperation of the United States Department of Agriculture, the large private herbarium of Dr. Otto Buchtien, formerly director of the Museo Nacional, La Paz, Bolivia, built up by him through many years of botanical exploration in South America and through exchanges with institutions in many parts of the world. The herbarium consists of approximately 45,000 specimens, and is notable for its large proportion of tropical American species, particularly of the floras of Bolivia, Chile, Argentina and Paraguay.

THE thirty-fourth meeting of the German Society of Internal Medicine will be held at Wiesbaden from April 24 to April 27, under the presidency of Professor L. Brauer. The chief subjects for discussion will be jaundice, introduced by Professor Eppinger, of Vienna, and the hypophysis, introduced by Professor Biedl, of Prague.

THE American Medical Association announces that the committee on therapeutic research of the Council on Pharmacy and Chemistry will consider applications for grants to assist research in subjects which, in the opinion of the committee, are of practical interest to the medical profession, and which research might not otherwise be carried out because of lack of funds. Requests should state the specific problem which is to be studied, the qualifications of the investigator, the facilities available to him, and, if work is to be undertaken in an established research institution, the name of the individual who will have general supervision. The committee will also appreciate offers from research workers to undertake investigations of questions which may be suggested by the council. Applications should be addressed to Chairman, Therapeutic Research Committee, Council on Pharmacy and Chemistry, 535 North Dearborn Street, Chicago, Illinois.

IT is announced in *La Géographie* for November 1921 that an attempt to cross the Sahara with twelve motor vehicles will shortly be made. The starting-point will be Tuggurt, the terminus of the Algerian railway, and the proposed route leads by Insalah, the Hogger region, and Adar of the Iforas, to Bureni on the Niger, 200 kilometers east of Timbuktu. The leader of the expedition will be Commandant Lafargue, and it will include a dozen members representing various government departments and other interests, among them being a cinema operator. It is hoped that the difficulty caused by the evaporation of the motor spirit in so torrid a climate has been overcome, but it is pointed out that there is a vast difference between the exceptional use of motor traction in this region for a special purpose, which may be feasible, and its regular commercial use.

DR. WALTER LIBBY, the historian of science, is delivering a novel series of lectures to the Industrial Fellows of the Mellon Institute of Industrial Research, the faculty members of the University of Pittsburgh, and the students of the graduate school of the university. The aim of this series of discourses is to discover the mental conditions of successful research. Dr. Libby takes account of certain phases of individual (or differential) psychology, deals with some of the more fruitful logical processes, and considers the means of stimulating the spirit of scientific discovery. The illustrative material is drawn from the records of the progress of chemistry and other sciences. The following is an outline of the course of lectures: (1) The Scientific Imagination; (2) The Hypothesis; (3) Conceptual Thinking; (4) Induction (contrasted with Deduction); (5) Reasoning by Analogy; (6) The Nature of Cause; (7) Experiment and Observation; (8) Scientific Laws; (9) Social Stimulation of Investigation; (10) The Suggestive Value of the Industries; (11) The Classification of the Sciences; (12) The Genetic Method. Dr.

Libby devotes a part of each period, say, twenty minutes of the hour, to a colloquium or critical discussion of the nature and application of the subject under consideration. In this way scientific technic is deliberated upon in all its aspects. These lectures are being delivered from 8:30 to 9:30 a.m. on Tuesday of each week of the present university semester, in the Fellows' Room of the Mellon Institute.

UNIVERSITY AND EDUCATIONAL NOTES

THE will of the late Miss Janet Williams, of Frederick, Md., contains a bequest of $30,000 to Hood College, to create and maintain an astronomical building in memory of her father, John H. Williams, to be known as the Williams Observatory.

FESTIVITIES are being planned for this spring in honor of the founding of the University of Padua in 1222. Professor Lucatello, the rector of the university, is in charge of the arrangements.

THE Japanese ambassador at Vienna has presented the sum of 6,500,000 crowns to the university as a personal donation in tribute to the scientific work being done there in spite of the unfavorable circumstances.

DR. CLARENCE C. LITTLE was elected president of the University of Maine on April 7. Dr. Little graduated from Harvard in 1910 and received the doctor's degree in 1914. In 1916 he became an assistant dean of Harvard College and research fellow in genetics for the Cancer Commission of Harvard University. Since his discharge from the army as major he has been research associate in the Station for Experimental Evolution of the Carnegie Institution.

DR. D. S. ROBINSON, assistant professor of philosophy at University of Wisconsin, has accepted the professorship of philosophy at Miami University. Dr. E. E. Powell has held the chair of philosophy since 1905 and resigns the chair at the close of this year to devote his time to writing.

JOHN ARTHUR RANDALL, secretary of the Advisory Board of the General Staff of the War Department, has been appointed president of Rochester Mechanics Institute. Mr. Randall was selected by the trustees to continue the development of a technical educational program containing liberal components.

DR. GEORGE THOMAS, formerly professor of economics in the University of Utah and since 1921 superintendent of public education in Utah, has been installed as president of the university.

DISCUSSION AND CORRESPONDENCE

POPULAR SCIENCE

TO THE EDITOR OF SCIENCE: I am very much interested in Dr. Slosson's letter about popular science writing which appears in SCIENCE for March 3, just received. Since some of my own information and experience is along this line it may be worth while for me to make some additional comment.

I think that I can see a large number of conditions involved in the fact mentioned by Dr. Slosson that there is a dearth of popular science writers in this country, but I shall only discuss one or two of them. First and foremost is the malodorous condition of the popular science field which for some time has been so largely and so conspicuously occupied by fabricators, exaggeraters, emotionalists, ignoramuses and exploiters that many people of training and ability hesitate to enter. Furthermore if an entrance is attempted by use of an informative article of clarity and real merit the author may have the humiliation of seeing his work rejected for that of some irresponsible clown or gaudy sentimentalist who is successful in assembling a group of highly stimulating words ("lots of pep") which may or may not have some relation to fact.

Even more important than such discouragement to potential writers is the effect of lax, inaccurate and falsified statement of scientific material upon the reading public. I am sure that for a period of fifty years more hoaxes have been perpetrated by newspapers in the name of science than in any other way. As much as thirty years ago most intelligent people were suspicious of material presented by the public press as science. In the last

twenty years this suspicion has been more than justified and many intelligent readers say they either do not read or do not believe the stuff peddled as science by most newspapers. Under such conditions why should the reading public take any interest in popular science writing? For killing this interest the press services, feature syndicates and syndicated newspapers (aided and abetted by renegade scientists and pseudo-scientists) are to blame rather than individual newspapers. This is partly because of commercialized ideas of service, partly because of the mass of material handled and partly because of remoteness from contact with the reading public.

The lack of interest in scientific matter is also probably increased to some extent by the fact which Dr. Slosson mentions as making it appear strange, *i. e.*, the increased teaching of science in our schools. The well informed student is thereby made more critical of the material presented. At the same time his parents become more cautious in reading or referring to it because they fear his ridicule when some point is raised involving inaccurate or garbled press reports.

In my own case I admit very freely that I am fully in sympathy with the man who hesitates to try popular science writing because of its unsavory reputation. I sometimes have a very distinct feeling of disgust when I find an article which I have tried to compose accurately and which I have taken especial pains to verify, printed in close proximity to one of the florid, vacuous, or untruthful type. On the other hand there is a lot of satisfaction when it gets on the editorial page in dignified company, as sometimes occurs.

For nearly three years our institution has been sending out to a number of California newspapers (our present mailing list is fifty-three) biological feature articles written by myself. These have been sent at intervals of one or two weeks free of charge, partly as a matter of experiment but mainly as a sort of university extension activity. We are convinced that the service has educational value and that it is helping to popularize true science. I have myself been surprised at times by the interest expressed in certain articles by people whom I would not have expected to read them, much less express appreciation of them. I have personally interviewed about sixty editors and have had interesting correspondence with others. A large number have shown such interest in my material that I am convinced that the general public is interested in good stuff if properly presented. If eight or nine out of every ten editors express interest in carefully verified scientific material written in popular (non technical and simple and direct) style I am inclined to think that a similar percentage of intelligent readers will do so if one will take time to gain their confidence.

I appreciate the difficulties confronting Dr. Slosson and Science Service and, like him, I am impatient at delay but when I think about how badly the American public has been served in regard to scientific news I realize that it will take long and hard work by a lot of people to get popular science writing on a basis to inspire confidence. There is always the risk that one who finds he can write in popular style will become more interested in the popular side of it than in the science (truth telling) side of writing and will become unreliable, as has often occurred in the past. Hence it is quite evident that the great need is not only for writers of popular style, of scientific training and ability, but also of high ideals of service which can not be broken down under the stress of temptation.

W. E. ALLEN

SCRIPPS INSTITUTION FOR BIOLOGICAL RESEARCH

TWO NEW WESTERN WEEDS

DURING the past year two plants, which threaten to become weeds of some importance in the arid and alkaline regions of the West, have been received from the western states. One of these is *Bassia hyssopifolia* (Pall.) Kuntze, a member of the family Chenopodiaceæ, originally described from the region of the Caspian Sea. It apparently has never been recorded as occurring in this country. The first collection was made at Fallon, Nevada, July 28, 1919, by Ivar Tidestrom (No. 10755), and a considerable amount of material for distribution has recently been sent me by F. B. Head-

ley, superintendent of the Newlands Experiment Farm, Fallon, Nevada, which he collected at that place in August, 1921. Mr. Headley reports that the plant is becoming very abundant in that section, but that it has not yet invaded fields of growing crops on good soil, so that it may not prove to be a serious pest. It makes a rank growth on soil which is too alkaline for the usual cultivated crops, and is found in fields which have received no irrigation as well as in those which have been frequently irrigated. Additional specimens have recently been received at the U. S. National Herbarium collected by Professor H. M. Hall (No. 11751) at Los Baños, Merced County, California, October 10, 1921, and by Elias Nelson (No. 1002) at Yakima, Washington, October 3, 1921. Mr. Nelson reports that this plant has appeared during the past five years in the Yakima Valley, where it is spreading, and that it is eaten greedily by stock.

Bassia hyssopifolia is an annual, with much the habit of *Chenopodium album*. The flowers are glomerulate in the axils of small bracts, and are borne in short or elongate slender paniculately arranged woolly spikes, at first usually dense, later elongate and interrupted. Each of the five perianth segments at maturity bears on its back a spine incurved into a hook.

A second weed which apparently has not been reported from this country is *Centaurea picris* Pall., also a native of the Caucasus. Specimens were first recived in May, 1921, from Mr. C. O. Townsend, who reported that the plant was said to be a bad weed in the vicinity of Salt Lake City. Specimens from Idaho Falls, Idaho, collected by Miss Ayres of the Idaho Seed Laboratory, have been forwarded during the past year to Mr. E. Brown of the United States Department of Agriculture by Miss Anna M. Lute of the Colorado Seed Laboratory. Miss Ayres reports that the plant is becoming a serious pest in some parts of Idaho. The species has also been collected during the past year at Clifton, Kansas, by Mr. J. W. Head. Mrs. E. P. Harling of the Kansas State Agricultural College, who has investigated this occurrence, believes that the species may have been introduced in Turkestan alfalfa seed. The only North American specimen in the National Herbarium is one collected at Courtney, Missouri, in 1914, by B. F. Bush (No. 7152).

Centaurea picris is one of the knapweeds or star-thistles of the Old World, numbering several hundred species, some of which have become weeds in this country, while a few others are cultivated for their flowers or foliage. It is a several-stemmed perennial, somewhat tomentose or glabrate, with pinnatifid or dentate lower leaves, smaller and entire upper ones, and rosy or pink medium-sized discoid heads, and is especially characterized among the species known from this country by its involucral characters. The phyllaries are roundish to oblong, with greenish bases and scarious whitish obtuse to acuminate entire or subentire appendages, those of the inner phyllaries somewhat pilose.

It is evident that both of these plants find in the arid alkaline regions of the West a habitat similar to that of their Old World home, and unless measures are taken for their destruction, they may become serious pests, as has been the case in recent years with such plants as the "Russian thistle" (*Salsola pestifer*) and the prickly lettuce (*Lactuca scariola integrata*).

S. F. Blake
Bureau of Plant Industry,
Washington, D. C.

CAT-TAIL (TYPHA LATIFOLIA) AS A FEED

Experiments conducted on the writer's farm demonstrate the practical value of cat-tail as a feed for hogs. Sixty head were turned into a three-acre cat-tail swamp, and obtained sufficient nutriment from the rhizomes to keep them in good flesh for three months. No illness or digestive disturbance was noted.

The following table compares yellow (raw) corn with cat-tail flour, as analyzed by J. A. Le Clerc:

	Corn	Cat-tail
Moisture	6.96	7.35
Ash	0.82	2.84
Fat	2.82	0.65
Protein	7.88	7.75
Carbohydrate	80.83	81.41

The large amount of food material contained

in the starchy central core of the typha rhizome was shown by A. P. Claassen, who estimated that one acre would yield a total dry weight of 10,792 pounds of cat-tail rhizomes, or more than two tons of flour, made from the central core.

Typha may be used as a substitute for high-priced corn. It would seem that the best time for feeding would be in the fall and winter, as the starchy content is likely to be highest then.

L. E. FREUDENTHAL

ROSALIE FARM,
LAS CRUCES, NEW MEXICO

SOIL SHIFTING AND DEPOSITS

MR. PETERSON'S article on deposition of soil in the Palouse area of eastern Washington and Idaho, which appeared in SCIENCE, January 27, 1922, should prove of interest and value to foresters as well as agriculturists in this region. The questions naturally arise: How far is this soil carried into the Bitterroot mountains, and how does it influence the character of the soil and vegetation within the forest areas? The writer's observations in this respect may be of interest in this connection.

Dust storms, commonly referred to as "Palousers," are of comparatively frequent occurrence throughout northern Idaho and northwestern Montana. They accompany high winds from the west and southwest; they are well known and despised by housekeepers in Kalispell, Missoula, Thompson Falls, Libby and all surrounding towns. The dust penetrates into every house and office. When accompanied by rain the window panes and buildings are besmirched with streaks of red soil. One of these storms in March, 1917, laid down on the snow within the timbered region of northern Idaho about 600 pounds of dust per acre. The dust from that storm hung on the trees, even at 6,000 feet elevation, along the Kootenai-Priest Divide throughout the summer of 1917. Settlers say that dust storms are common along the Cœur d'Alene, St. Joe and Clearwater rivers.

The writer has noted the billowy soil surface, unmistakably due to surface shifting of the soil, as far east as Pierce, Idaho, about eighty miles east of Moscow. The soil is unusually deep and fertile and the vegetation is more profuse, with better growth of timber, over the larger portion of the Clearwater Forest in Idaho than occurs on the forests farther north or on the forests of western Montana. It is of interest to note that the Clearwater forest lies directly in the path of the strong west winds from the arid parts along the Columbia River, and that Lewis and Clark, as early as 1806, called attention to the unusually deep and seemingly fertile soil in the Clearwater basin.

These observations lead to the supposition that the accumulation and shifting of soil on the Palouse area have been effective in preventing natural establishment of the forest here in the past, though climatic records indicate that the area should grow western yellow pine; and they strengthen the belief that the unusually good growth of timber, profuse vegetation, and deep soils on certain parts of the western slopes of the Bitterroot mountains in Idaho, are due partly to the fact that soil is carried in by the westerly winds from lava plateaus along the Snake and Columbia rivers.

J. A. LARSEN

MISSOULA, MONTANA

QUOTATIONS

AN INTERNATIONAL LANGUAGE

THERE is an increasing demand among scientific men for international agreement as to the choice of a universal auxiliary language. After a long struggle, many of the fundamental tools of thought have been unified. All nations now use the same system of numbers, Arabic numerals, measurements of latitude and longitude, mathematical symbols, chemical formulæ, and, at least in science, the metric system.

But language, the master-key to thought and the vehicle of communication, remains under the curse of Babel. Were it possible by acquiring a second language in addition to the natal language to convey ideas to fellow-workers in every part of the world and to receive their ideas, one of the greatest barriers to the progress of science would be broken down. Time and money would be saved, overlapping of

effort prevented, and precision of ideas would be assisted.

For many years there have been efforts towards the establishment of an international language, but chiefly by private persons or by associations formed directly for that purpose. Since 1919, however, governmental, scientific, and international bodies have given serious attention to the practical possibilities. At the meeting of the International Research Council, held in Brussels in the first summer after the war, a committee was appointed to investigate and report on the general problem of an international auxiliary language, and to cooperate with similar bodies established or that might be established for the same purpose.

The Section for Education of the British Association at the Bournemouth meeting appointed a committee which reported to the Edinburgh meeting last autumn. The American Association soon afterwards took a similar step, and its report was presented to the meeting at Toronto last December. The French and Italian Associations have also appointed committees, but as yet these have not issued reports. The delegates representing 12 states presented a resolution in the Assembly of the League of Nations last September taking the definite step of recommending Esperanto, and hoping that the teaching of that language would be made more general in the whole world, so that children of all countries might know at least two languages.

In accordance with the procedure of the league, this motion was referred to a committee under the chairmanship of Lord Robert Cecil. The committee was of the opinion that the question, in which "an ever-increasing number of great states" was interested, should be studied attentively before being dealt with by the Assembly. Accordingly, it is being studied by the secretariat. The British Association committee went further, and definitely recommended the choice of an artificial language, but hesitated to decide between those which have been invented. The American Association recognized the "need and timeliness of fundamental research on the scientific principles which must underlie the formation, standardization, and introduction of an international auxiliary language," and recommended further study.

These various bodies are free from the suspicion of advocating serious study of what might be regarded as a "fad." It is fair to accept their action as witness to the urgency of the problem. There is also evidence of their agreement that an auxiliary language, if it is to serve its purpose, must receive almost universal adoption.

The only suggestions which have received sufficient support to be ranked as serious candidates are Latin, English, Esperanto, and Ido. Latin was at one time the common medium of many nations and has retained a wide currency, directly in religion, less directly in some branches of science, and as the basis of the Romance languages. It is elegant and concise, has a definite system of forming new compounds and derivatives, and, as a dead language, its roots have unchanging significance. But its grammar is difficult; it has many exceptions and irregularities. The revival of Latin would require the coining of a very large number of new words.

English is widely used and is spreading rapidly; its grammar is relatively simple and its vocabulary is rich. But the choice of one among many widespread living tongues would excite a just jealousy. Its spelling is chaotic, and its pronunciation difficult and various. Moreover, a living language reflects the changing activities and emotions of the people who use it in literature and in daily speech, and is therefore unsuited as a vehicle for the cold and precise exchange of international knowledge.

The invented language Esperanto has already made great progress as an international auxiliary tongue; it has held 12 international congresses in different countries; it is taught in schools in Geneva, Breslau, Milan, Czecho-Slovakia, and Bulgaria. Its grammar, pronunciation, and method of word-building are simple, scientific, and easy to acquire, and its root-words have been carefully selected. Ido claims to be a later and improved form of Esperanto; hitherto it has had a smaller vogue, but in appearance and sound it is more attractive.

The balance of advantages seems to lie with the selection of either Esperanto or Ido or some modification of them recommended by experts on language. The vital requirement is that the auxiliary language should be kept auxiliary, the vehicle of formal statement. If it should become a language of common speech, of emotion, or of literature it will at once fail of its purpose and be only an additional linguistic burden.—London *Times*.

SPECIAL ARTICLES

ATOMIC STRUCTURE

THERE has been considerable discussion in the literature, during the past few months, of the Lewis theory of atomic structure[1] and Langmuir's extension of it to the heavy elements.[2] In 1919 and 1920 the writer worked out a somewhat different extension of this theory. For various reasons its publication has been delayed, but in a few months a paper describing it in some detail is to appear. Because of this delay, a short outline of the theory may not be out of place here.

The *number* of electrons in each shell of the lighter atoms is the same as in the original Lewis theory. It is assumed, however, that the fifth, sixth, seventh and eighth electrons in the second and third shells pair off with the first four, the distance between the electrons in each of these pairs, and also in each pair formed by bonding between atoms, being much less than the distance between pairs. These shells are therefore tetrahedra of pairs instead of cubes of single electrons.[3] The electrons in each shell (after the second) tend to be placed opposite the centers of the faces of the imaginary polyhedron formed by the electron groups in the underlying shell. If a certain shell is a tetrahedron, the next shell out will also be a tetrahedron; if the inner shell is a cube, the outer shell will be an octahedron (six points, eight faces); and if the smaller shell is an octahedron, it will be surrounded by a tetrahedron—four of its eight faces then being occupied—or by a cube.

[1] *J. Am. Chem. Soc.*, 38: 762 (1916).
[2] *Ibid.*, 41: 868 (1919).
[3] *Cf.* Lewis, *loc. cit.*, p. 779.

When the nuclear charge becomes sufficiently great, the same forces which cause pairing of electrons in nitrogen result in the formation of triplets in the inner shells of the heavier atoms. The type of force between electrons necessary to account for these phenomena is discussed in my longer paper and will not be considered here. As one after another of the outer electrons are drawn into an inner shell to form triplets, the remaining pairs are pushed further and further from the nucleus. This may result in rearrangement of the kernel structure, as indicated in the examples of atomic structure given below. Often, in different environments, different kernel structures are stable, some having more valence electrons and fewer triplets than others, etc.

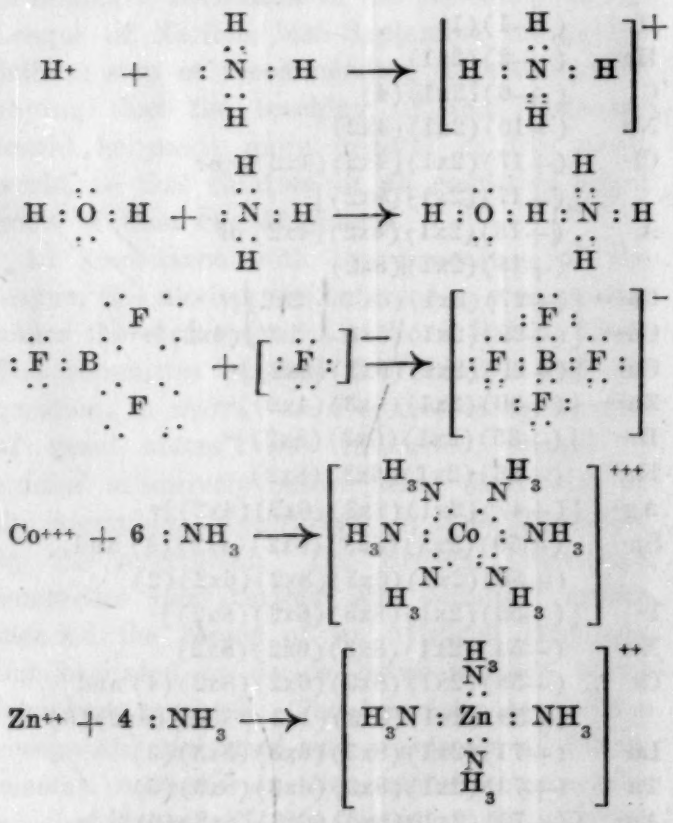
The structures resulting from the application of the foregoing ideas I shall represent by means of formulæ, in which the first parenthesis represents the nucleus and indicates its charge, the remaining parentheses each representing a shell of electrons, in order from the nucleus out. The number of electron-groups and the number of electrons in each group are indicated for every shell, except (in some cases) the valence shell. Formulæ for atoms and ions of some of the elements follow:

H	$(+1)(1)$
He	$(+2)(2x1)$
C	$(+6)(2x1)(4)$
Ne	$(+10)(2x1)(4x2)$
Cl^-	$[(+17)(2x1)(4x2)(4x2)]^-$ or $[(+17)(2x1)(8x2)]^-$
A	$(+18)(2x1)(4x2)(4x2)$ or $(+18)(2x1)(8x2)$
Co^{+++}	$[(+27)(2x1)(6x3+2x2)]^{+++}$
Cu^{++}	$[(+29)(2x1)(5x3+1x2)(4x2)]^{++}$
Cu^{+}	$[(+29)(2x1)(6x3)(4x2)]^{+}$
Zn^{++}	$[(+30)(2x1)(6x3)(4x2)]^{++}$
Br^-	$[(+35)(2x1)(6x3)(8x2)]^-$
Kr	$(+36)(2x1)(6x3)(8x2)$
Ag^+	$[(+47)(2x1)(8x3)(6x2)(4x2)]^+$
Sn	$(+50)(2x1)(8x3)(6x2)(4x2)(4)$ and $(+50)(2x1)(6x3)(8x2)(6x2)(2)$
I^-	$[(+53)(2x1)(8x3)(6x2)(8x2)]^-$
Xe	$(+54)(2x1)(8x3)(6x2)(8x2)$
Ce	$(+58)(2x1)(8x3)(6x2)(8x2)(4)$ and $(+58)(2x1)(8x3)(1x3+5x2)(8x2)(3)$
Lu	$(+71)(2x1)(8x3)(6x3)(8x3)(3)$
Ta	$(+73)(2x1)(8x3)(6x3)(8x3)(5)$
Au^+	$[(+79)(2x1)(8x3)(6x3)(8x2)(6x3)]^+$

Hg (+80)(2x1)(8x3)(6x3)(8x2)(6x3)(2)
and (+80)(2x1)(8x3)(6x3)(8x3)(6x2)
Nt (+86)(2x1)(8x3)(6x3)(8x3)(6x3) or
(+86)(2x1)(8x3)(6x3)(8x2)(6x3)(4x2)

These and similar formulæ for the other elements express very satisfactorily their known chemical, physical and crystallographic properties. By applying this theory to crystal structures, it has been found possible to determine the arrangements of electrons in nearly all crystals for which the arrangements of atomic centers were already known, and also the atomic and electronic structures *in many cases in which even the atomic marshalling was previously unknown.* These structures furnish incontrovertible proof that this theory of atomic structure, fundamentally and in many of its details, is correct.

An important part of the theory is the idea that a single bond may be formed not only by the attraction between two atoms, each of which contains an unpaired electron in its valence shell, the two single electrons forming a pair, but also by the attraction of an atom containing a "lone electronpair"—one not acting as a bond—for another capable of holding on to this lone pair. The following are typical reactions of this type:



In the last two cases the lone pairs of the nitrogen atoms become bond pairs, assuming positions at octahedron corners opposite the six faces of the distorted cube of the cobalt kernel and at tetrahedron corners opposite the four previously unoccupied faces of the zinc kernel octahedron (or, what is the same thing, opposite the four faces of the zinc kernel tetrahedron). We thus have an entirely satisfactory picture of Werner's "auxiliary valencies" and "coordination numbers." In some cases (*e. g.*, in $Ag(NH_3)_2^+$) all the faces of the kernel polyhedron are not occupied. (In the silver iodide crystal, each silver kernel is surrounded by four electronpairs at tetrahedron corners, showing its true coordination number to be *four.*)

This theory has not yet been applied to the explanation of spectra; nor is it possible to give the *exact* positions of the electrons in each atom. These positions may in fact be merely the centers or foci of electronic orbits. In these and other respects the theory is still incomplete.

Maurice L. Huggins
University of California

A SIMPLE BUBBLING HYDROGEN ELECTRODE

The electrode described in this paper is the result of an attempt by the writer to combine the principles of the bubbling type of electrode with simplicity of construction and the necessity for only a small amount of solution. That this has been accomplished, seems to be apparent from a study of the accompanying diagram and the behavior of the electrode in numerous tests.

Four models similar to the one shown in the diagram were constructed by the writer and compared with each other and a Bailey electrode. Various standard buffer solutions were tested and it was found that all electrodes gave results that agreed within .3 of a millivolt, which was the limit of accuracy of the galvanometer in the set up.

While the models constructed by the writer require only about 1.5 c.c. of solution, there seems to be no good reason why, with proper

precautions, they can not be constructed for smaller amounts of solution. This can be accomplished, not by a smaller model of the same shape, but by making the bottom of the electrode vessel more conical in shape and taking particular precautions in sealing the electrode as near the base of the vessel as is conveniently possible. It is not desirable to materially decrease the diameter of the upper portion of the electrode vessel, because in so doing, the bubbling process is seriously interfered with.

CONSTRUCTION AND OPERATION

The electrode vessel *E* was made by sealing a short piece of glass tubing to an ordinary three inch soda-lime tube. The glass tube was then bent into position to make the side arm, *A*. The electrode proper, which consists of a piece of platinum foil, was sealed as near the base of the main vessel as possible. The protruding end of the foil was bent into a loop and partially embedded in sealing wax to give added mechanical strength. The rubber stopper, *D*, is used to prevent the rapid diffusion of air into the electrode vessel. The support, *S*, shown in the diagram by means of dotted lines, was made from a No. 12, two-holed rubber stopper by cutting out the portion between the holes.

After platinization of the electrode, about 1.5 c.c. of the solution to be tested are put into the electrode vessel, *E*. Purified hydrogen is bubbled through the solution by way of the side arm, *A*. Usually, about three minutes of bubbling are required for saturation.

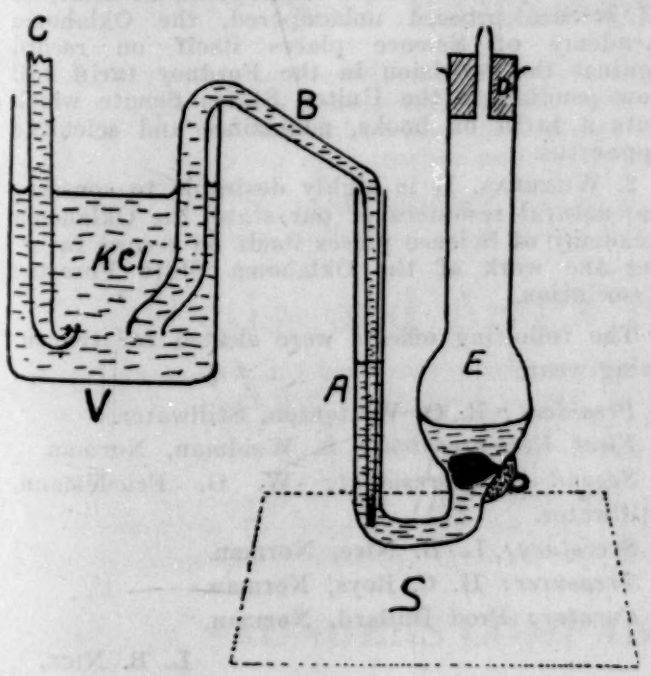


FIG. 1

The diagram shows the electrode in position for a measurement. *C* represents the side arm of the calomel electrode, *V*, a vessel containing a saturated KCl solution, and *B*, a tube filled with saturated KCl and plugged at the smaller end with filter paper to prevent the too rapid siphoning of KCl from *V*.

When properly constructed, this electrode possesses the following features, which should make it applicable for quite general use:

1. Simplicity of construction.
2. Ease of operation.
3. Requires only a very small amount of solution for a determination.

J. ROY HAAG
PENNSYLVANIA STATE COLLEGE

THE OKLAHOMA ACADEMY OF SCIENCE

THE tenth annual meeting was held in Oklahoma City, on February 10, and at the University of Oklahoma, Norman, on February 11, 1922. The following papers were read:

FEBRUARY 10

Presidential address: *The possibility of the redemption of the Great Plains from its semi-arid condition*: J. B. THOBURN.

Some notes on the Bois Fort Chippewa of Minnesota: ALBERT B. REAGAN.

Identification of Anthoceros in the Oklahoma cryptogamic flora: M. M. WICKHAM.

Notes on the migration of Macrochelys lacertine: M. M. WICKHAM.

Further notes on migration of Terrapene carolina in Oklahoma: M. M. WICKHAM.

Identification of fresh water sponges in the Oklahoma fauna: M. M. WICKHAM.

Red and white blood corpuscles and catalase in the blood of non-complement guinea pigs: L. B. NICE, A. J. NEILL and H. D. MOORE.

The regular tetrahedron in relation to its cube and other solids: OSCAR INGOLD.

Oklahoma geography in the high schools: C. J. BOLLINGER.

The poisonous substance in cotton seed: PAUL MENAUL.

The chemistry of the pecan: W. G. FRIEDEMANN.